

A System For Detecting The Deployment Of A Landing Gear Of An Aircraft And A Method Thereof

Cross-Reference to Related Applications

[0001] The present application claims the benefit of Singapore Patent Application No. 10202009789R filed on 1 October 2020, which is incorporated by reference herein.

Technical Field

[0002] The present invention relates to a system for detecting the deployment of a landing gear of an aircraft and a method thereof.

Background

[0003] When an aircraft is landing onto a runway, it requires a landing gear to enable it to land safely. When the aircraft is approaching the runway, it flies along a “final approach” of its flight path before reaching the landing zone. At this juncture, the aircraft would be near to the runway and the position of the landing gear should be in extended position. If the landing gear is in a retracted position when it is along the final approach, the body of the aircraft may land onto the runway resulting in aircraft damages and possibly passenger casualties. The final approach is the last leg in the flight path of the aircraft as it approaches to land on the runway. The final approach flight path is a descending flight path in the direction of landing along an extended runway centreline from base leg towards the runway. The aircraft has to be aligned with the extended centreline of the runway in preparation for subsequent descending and landing on the runway. Aircraft typically turn from base leg to final approach within one to two miles from the airport. An aircraft will typically follow an approach slope on its final approach flight path to eventual touchdown on the runway landing zone. The approach slope is typically 3 degrees from the horizontal.

[0004] While there are onboard systems to detect the deployment of the landing gear, the onboard systems may not be able to detect the unsuccessful deployment of the landing gear due to system failure, e.g. signal failure, etc.

[0005] Further, while the operators at the control tower may be able to observe the deployment of the landing gear when an aircraft is landing, the operators may not be able to see the landing gear if the visibility condition is poor due to weather conditions, fog, etc. The visibility conditions may be categorised into different categories. For example, Cat II represents standard operations with associated Runway Visual Range (RVR) ranging from 550m (1,800 feet) to 300m (1,000 feet), Cat IIIa represents a precision instrument approach and landing operation with RVR not less than 175m (600 feet), Cat IIIb represents a precision instrument approach and landing operation with RVR less than 175m (600 feet) but not less than 50m (200 feet), Cat IIIc represents a precision instrument approach and landing operation with no RVR limitations, i.e. even zero visibility. Depending on the geographical location of the airports, the visibility of the runways at airports may vary and are categorised accordingly. In extreme weather conditions, the operators are not able to see the landing gear at all.

[0006] Therefore, it is important to have a solution to detect the deployment of the landing gear during the landing of the aircraft.

Summary

[0007] According to various embodiments, a method for detecting the deployment of a landing gear of an aircraft during landing is provided. The method includes monitoring an area of interest along a flight path of the aircraft, detecting the aircraft when it enters the area of interest, identifying a section of the aircraft where the landing gear deploys, capturing at least one of a visible light image and a thermal image of the section, and detecting the deployment of the landing gear in at least one of the visible light image and the thermal image.

[0008] According to various embodiments, the area of interest may be at a portion of a final approach of the flight path.

[0009] According to various embodiments, monitoring the area of interest may include capturing a plurality of visible light images and a plurality of thermal images of the area of interest over a period of time.

[0010] According to various embodiments, detecting the aircraft may include identifying the aircraft in one or more of the plurality of visible light images and the plurality of thermal images.

[0011] According to various embodiments, the method may further include tracking the movement of the aircraft along the final approach of the flight path.

[0012] According to various embodiments, capturing the at least one of the visible light image and the thermal image of the section may include capturing at least one of the enlarged visible light image and the enlarged thermal image of the section.

[0013] According to various embodiments, detecting the deployment of the landing gear may include identifying the landing gear in the extended position in the at least one of the visible light image and the thermal image of the section or the at least one of the enlarged visible light image and the enlarged thermal image of the section.

[0014] According to various embodiments, the method may further include generating an alert signal to indicate the deployment of the landing gear when the landing gear may be detected to be deployed.

[0015] According to various embodiments, a system for detecting the deployment of a landing gear of an aircraft during landing is provided. The system includes a thermal camera comprising a first field of view and adapted to monitor an area of interest along a flight path of the aircraft and capture a thermal image of the area of interest, a visible light camera comprising a second field of view and adapted to monitor the area of interest and capture a visible light image of the area of interest. The system further includes a processor in communication with the thermal camera and the visible light camera, a memory in communication with the processor for storing instructions executable by the processor, such that the processor may be configured to monitor the area of interest along the flight path of the aircraft, detect the aircraft when it enters the area of interest, identify a section of the aircraft where the landing gear deploys, capture at least one of a visible light image and a thermal image of the section, and detect the deployment of the landing gear in at least one of the visible light image and the thermal image.

[0016] According to various embodiments, the area of interest may be at a portion of a final approach of the flight path.

[0017] According to various embodiments, to monitor the area of interest, the processor may be configured to capture a plurality of visible light images and a plurality of thermal images of the area of interest over a period of time.

[0018] According to various embodiments, to detect the aircraft, the processor may be configured to identify the aircraft in one or more of the plurality of visible light images and the plurality of thermal images.

[0019] According to various embodiments, the processor may be further configured to control the visible light camera and the thermal camera to track the movement of the aircraft along the final approach of the flight path.

[0020] According to various embodiments, the visible light camera and the thermal camera may be configured to zoom into the section of the aircraft to capture an enlarged visible light image and an enlarged thermal image of the section, such that capturing at least one of the visible light image and the thermal image may include capturing at least one of the enlarged visible light image and the enlarged thermal image of the section.

[0021] According to various embodiments, to detect the deployment of the landing gear, the processor may be configured to identify the landing gear in the extended position in the at least one of the visible light image and the thermal image of the section or the at least one of the enlarged visible light image and the enlarged thermal image of the section.

[0022] According to various embodiments, the processor may be configured to generate an alert signal to indicate the deployment of the landing gear when the landing gear is detected to be deployed.

Brief Description of Drawings

[0023] Fig. 1 shows a schematic diagram of an exemplary embodiment of a system for detecting the deployment of a landing gear of an aircraft during landing.

[0024] Fig. 2A shows an exemplary embodiment of the system.

[0025] Fig. 2B shows the system in Fig. 2A capturing at least one of the visible light image and the thermal image of the section of the aircraft.

[0026] Fig. 3 shows an exemplary embodiment of an enlarged visible light image of the landing gear as captured by the visible light camera.

[0027] Fig. 4 shows a flow diagram of an exemplary method for detecting the deployment of a landing gear of an aircraft during landing.

[0028] Fig. 5 shows a flow diagram of an exemplary method of detecting the deployment of the landing gear of an aircraft during landing.

Detailed Description

[0029] In the following examples, reference will be made to the figures, in which identical features are designated with like numerals.

[0030] Fig. 1 shows a schematic diagram of an exemplary embodiment of a system 100 for detecting the deployment of a landing gear 22 (not shown in Fig. 1) of an aircraft 20 during landing. System 100 includes a thermal camera 110 comprising a first field of view 110F and adapted to monitor an area of interest 112 along a flight path of the aircraft 20 and capture a thermal image of the area of interest 112, a visible light camera 120 comprising a second field of view 120F and adapted to monitor the area of interest 112 and capture a visible light image of the area of interest 112, a processor 132 in communication with the thermal camera 110 and the visible light camera 120, a memory 134 in communication with the processor 132 for storing instructions executable by the processor 132, wherein the processor 132 is configured to monitor the area of interest 112 along the flight path of the aircraft 20, detect the aircraft 20

when it enters the area of interest 112, identify a section (not shown in Fig. 1) of the aircraft 20 (not shown in Fig. 1) where the landing gear 22 deploys, capture at least one of a visible light image and a thermal image of the section, detect the deployment of the landing gear 22 in at least one of the visible light image and the thermal image. System 100 may include a server comprising the processor 132, the memory 134, an I/O interface 136 configured to provide an interface between the processor 132 and peripheral interface modules, e.g. keyboard, mouse, touchscreen, display, etc. System 100 may include a communication module 138 configured to facilitate communication, wired or wirelessly, between the system 100 and other user devices, e.g. mobile devices, laptops, via the internet. System 100 may include a storage device 140 configured to store data. System 100 may include a display, e.g. monitor, touchscreen, for displaying signals, e.g. alert signal, to the operator.

[0031] System 100 is able to detect the deployment of the landing gear 22 during the landing of the aircraft 20, even under low visibility conditions. System 100 may be installed and deployed to provide surveillance capabilities for safe landing of aircraft 20, such as visual confirmation of aircraft 20 landing gear 22 and/or visual confirmation of touchdown within the designated landing zone. System 100 enables detection of the landing gear 22 for airports with Cat II visibility, Cat IIIa visibility, Cat IIIb visibility and Cat IIIc visibility such that it enables the detection of the landing gear 22 during poor visibility conditions, e.g. adverse weather conditions.

[0032] System 100 may include an image processing module 134M (see Fig. 1) configured to process images 110T, 120T captured from the thermal camera 110 and the visible light camera 120. System 100 may include a thermal camera 110 operating module 134T containing operating parameters of the thermal camera 110 for operating the thermal camera 110. System 100 may include a visible light camera 120 operating module 134V containing operating parameters of the visible light camera 120 for operating the visible light camera 120. The modules 134T, 134V, 134M may be stored in the storage device 140 and loaded into the memory 134 to be processed by the processor 132. Upon capturing the thermal image and visible light image, the images may be transmitted to the processor 132 to be processed. Processor 132 may receive and process the thermal image and the visible light image to detect the deployment of the landing gear 22.

[0033] Fig. 2A shows an exemplary embodiment of the system 200. System 200 may include a set of cameras 210S, i.e. the visible light camera 220 and the thermal camera 210. The set of cameras 210S may be mounted rigidly on an actuator 250 adapted to move the set of cameras 210S. Set of cameras 210S may be controlled by the processor 132 by activating the actuator 250 to monitor and capture the section 20S of the aircraft 20 for the detection of the deployment of the landing gear 22.

[0034] Actuator 250 may be a pan and tilt unit (PTU) adapted to pan and tilt the set of cameras 210S simultaneously so that the set of cameras 210S are able to have the same field of view and focus on the same area of interest 212. Actuator 250 may be adapted to pan the set of cameras 210S in the horizontal direction 210H and/or tilt the set of cameras 210S in the vertical direction 210V. Actuator 250 may be in communication with the processor 132 such that the processor 132 may be configured to remotely control the movement of the actuator 250 to pan and tilt the set of cameras 210S to detect and track the movement and position of the aircraft 20 flying within the final approach flight path for eventual landing on the runway. Actuator 250 may be installed on top of a support 252, e.g. a mast structure, which is typically located along the runway. Support may be located at a distance from the centreline of the runway so that it is possible for the set of cameras 210S to capture the aircraft 20.

[0035] Fig. 2B shows the system 200 in Fig. 2A capturing at least one of the visible light image and the thermal image of the section 20S of the aircraft 20. As shown in Fig. 2B, the aircraft 20 is at the final approach of the flight path and is about to land on the runway 202. Each set of cameras 210S may include the thermal camera 210 and the visible light camera 220, each having a field of view 210F, 220F and adapted to capture an area of interest 212. Both the field of views 210F, 220F of the visible light camera 220 and the thermal camera 210 may cover a specific area of interest 212 of the final approach of the flight path. Area of interest 212 may be at a portion of a final approach of the flight path, i.e. the area of interest 212 may cover part of the final approach flight path. Second field of view 210F of the visible light camera 220 may overlap with the first field of view 220F of the thermal camera 210. Hence, as a result of the overlapping field of views 210F, 220F, both the visible light camera 220 and the thermal camera 210 may detect the same section 20S of the aircraft 20. This would enable both the visible light camera 220 and the thermal camera 210 to acquire images of the selected area of

interest 212, i.e. the section 20S of the aircraft 20. As shown in Fig. 2B, the system 200 may be configured to detect the deployment of the landing gear 22 of the aircraft 20 during landing from the ground. It may also be possible to mount the set of cameras onto the aircraft 20 to detect the deployment of the landing gear 22 during landing from the aircraft 20.

[0036] System 200 may include a plurality of sets of cameras 210S spaced apart from each other along the runway 202. Each of the plurality of sets of cameras 310S may include the thermal camera 210 and the visible light camera 220.

[0037] Visible light camera 220 and the thermal camera 210 may perform continuous surveillance and monitoring of part of the final approach flight path. To do so, the system 200 may perform continuous surveillance and monitoring of a selected and pre-configured area of interest 212 which corresponds to the field of views 210F, 220F of the respective visible light camera 220 and the thermal camera 210.

[0038] Upon detection of aircraft 20 entering the final approach flight path, the processor 132 may control the actuator 250 to move the set of cameras to track the movement and position of the detected aircraft 20 as it flies along the final approach flight path, descend and eventually touchdown on the runway 202. Referring to Fig. 2B, when the aircraft 20 is flying along the final approach flight path, the visible light camera 220 and/or the thermal camera 210 may optically zoom-in into the aircraft 20 to capture an optically zoomed-in image of the landing gear 22. In this way, the visible light camera 220 and the thermal camera 210 may capture an enlarged visible light image 120E and an enlarged thermal image 110E of the section 20S of the aircraft 20, where the landing gear 22 may be deployed. The optical zoom-in for the visible light camera 220 may be performed by making appropriate adjustment to the second field of view 220F. Similarly, the optical zoom-in for the thermal camera 210 could be performed by making appropriate adjustment to the first field of view 210F. These adjustments to the respective camera's field of views 210F, 220F may be controlled remotely by the processor 132. Alternatively, it may be possible to digitally zoom into the section 20S of the aircraft 20 to obtain the enlarged visible light image 120E and the enlarged thermal image 110E of the section 20S of the aircraft 20.

[0039] Visible light camera 220 and/or the thermal camera 210 may be able to perform optical zoom-in into selected target or area of interest 212 which corresponds to the field of views 210F, 220F of the visible light camera 220 and the thermal camera 210. This may be achieved by making appropriate adjustments to the respective camera's field of views 210F, 220F. The field of views 210F, 220F may be remotely controlled by the processor 132. This would enable the visible light camera 220 and/or the thermal camera 210 to be able to acquire optically zoomed-in telephoto image of the selected target, e.g. an aircraft 20, flying within the final approach flight path or landing on the runway 202 and the landing gear 22. This would enable the system 200 to detect the position of the landing gear 22 and determine whether the landing gear 22 is in retracted or extended position, i.e. deployed. The position of the landing gear 22 may be detected by processing the visible light image from the visible light camera 220 and/or the thermal image from the thermal camera 210 by the image processing module.

[0040] Fig. 3 shows an exemplary embodiment of an enlarged visible light image 120E of the landing gear 22 as captured by the visible light camera 220. Similarly, Fig. 3 may represent an exemplary embodiment of an enlarged thermal image 110E of the landing gear 22 as captured by the thermal camera 210. Referring to Fig. 3, the position of the landing gear 22 may be in the extended position. When the landing gear 22 is in extended position, the landing wheel 22W, which is part of the landing gear 22 that contacts the runway, is extended outwards beyond the aircraft body 25. Image processing module 134M may process the enlarged visible light image 120E and the enlarged thermal image 110E of the landing gear 22 as captured by the visible light camera 220 and the thermal camera 210 to determine the position of the landing gear 22, i.e. whether the landing gear 22 is in extended position or retracted position, which is when the landing gear 22 is not visible on the aircraft body 25.

[0041] Thermal camera 210 detects the landing gear 22 by detecting the difference in thermal radiation level (or temperature) between the foreground, i.e. the aircraft 20, the landing gear 22, etc., and the background, i.e. the surrounding. Thermal camera 210 operates in the infrared spectrum and does not require any ambient light to enable it to "see" the foreground. Thermal camera 210 may also be commonly known as infrared thermal camera 210. Thermal camera 210 may be a Mid Wave Infrared (MWIR) camera or a Long Wave Infrared (LWIR) camera. Thermal camera 210 provides the advantage to detect the foreground under very low visibility conditions and even under zero illumination conditions, i.e. total darkness. Hence, the thermal

camera 210 provides the advantage of the ability to detect the aircraft 20 and landing gear 22 even under foggy weather conditions. Thermal camera 210 may capture and transmit images and video output in monochrome to the processor 132. Thermal camera 210 is entirely passive with no active transmissions or emissions, e.g. radio frequency, microwave, artificial illumination, infrared, laser and LIDAR etc. As such, the thermal camera 210 offers the following advantages, e.g. no interference with existing airport systems/equipment and aircraft systems/equipment, no interference with future airport systems/equipment and aircraft systems/equipment, no licensing and approval of frequency/spectrum required from airport and frequency spectrum regulator.

[0042] Unlike the thermal camera 210, the visible light camera 220 operates within the visible spectrum of light and hence requires some minimum amount of ambient visible spectrum light to enable it to “see” the aircraft 20 and landing gear 22. Visible light camera 220 is not able to detect the landing gear 22 when the visibility conditions are too poor or under zero illumination conditions. For example, the visible light camera 220 is also not able to detect the landing gear 22 when the visibility condition (above the runway surface) is very poor or in the presence of fog (above the runway surface). Visible light camera 220 is able to capture and transmit full colour and high-resolution images/video, e.g. Full HD (FHD) or 4K Ultra HD (4K UHD) resolution. The colour images in high resolution enables reliable and accurate visual verification and confirmation of the detected landing gear 22 by an operator, as well as reliable and accurate recognition of the landing gear 22 by the system 200. Therefore, the combined use of both the visible light camera 220 and the thermal camera 210 enables the system 200 to operate under very low visibility conditions, e.g. foggy weather conditions, to enable the system 200 to detect the landing gear 22 accurately and reliably. Visible light camera 220 is configured to capture and output visible light image 220M in colour and high resolution to the processor 132. Visible light camera 220 does not require any transmission of infrared illumination, visible spectrum illumination or laser illumination to operate. Being passive, the system 200 provides the advantage that it does not pose any hazard or cause any interference to other airport systems and/or aircraft systems, e.g. for aircraft landing/taking-off from the runway. System 200 provides the following advantages, no interference with existing airport systems/equipment and aircraft systems/equipment, no interference with future airport systems/equipment and aircraft systems/equipment, no licensing and approval of frequency/spectrum required from airport and frequency spectrum regulator.

[0043] Fig. 4 shows a flow diagram of an exemplary method 1000 for detecting the deployment of a landing gear 22 of an aircraft 20 during landing. Method includes monitoring an area of interest 112 along a flight path of the aircraft 20 in block 1010, detecting the aircraft 20 when it enters the area of interest 112 in block 1020, identifying a section of the aircraft 20 where the landing gear 22 deploys in block 1030, capturing at least one of a visible light image and a thermal image of the section in block 1040, and detecting the deployment of the landing gear 22 in at least one of the visible light image and the thermal image in block 1050.

[0044] System 100 may be configured to monitor the area of interest 112. To monitor the area of interest 112, the system 100 may be configured to capture a plurality of visible light images and a plurality of thermal images of the area of interest 112 over a period of time. Plurality of visible light images and the plurality of thermal images acquired by both the visible light camera 120 and the thermal camera 110 may be processed by the image processing module 134M. This would enable the detection and surveillance of the aircraft 20 flying within the final approach flight path. To detect the aircraft 20, the system 100 may be configured to identify the aircraft 20 in one or more of the plurality of visible light images and the plurality of thermal images. Image processing module may be configured to recognise the aircraft 20 and the landing gear 22 using image recognition model. Once the aircraft 20 is detected in the area of interest 112, the system 100 identifies that the aircraft 20 has entered the area of interest 112. System 100 may track the movement of the aircraft 20 along the final approach of the flight path so as to detect the deployment of the landing gear 22 during the final approach flight path.

[0045] Once the aircraft 20 is detected, the image processing unit 134M may be configured to identify the section 20S of the aircraft 20 where the landing gear 22 deploys. System 100 may operate the visible light camera 120 and the thermal camera 110 to zoom-in into the section 20S of the aircraft 20. System 100 may activate the visible light camera 120 and the thermal camera 110 to zoom in to the section 20S of the aircraft 20 to capture at least one of the enlarged visible light image 120E and the enlarged thermal image 110E of the section 20S.

[0046] To detect the deployment of the landing gear 22, the image processing unit 134M may identify the landing gear 22 in the extended position in the at least one of the visible light image and the thermal image of the section 20S or the at least one of the enlarged visible light image 120E and the enlarged thermal image 110E of the section 20S. Upon identifying the aircraft 20, the processor 132 may activate the visible light camera 120 and/or the thermal camera 110 to capture the visible light image and/or the thermal image of the aircraft 20. If the visible light camera 120 and the thermal camera 110 have been operated to zoom-in into the section 20S of the aircraft 20, the processor 132 may activate the visible light camera 120 and/or the thermal camera 110 to capture the enlarged visible light image 120E and/or the enlarged thermal image 110E of the aircraft 20.

[0047] If the image processing module detects the landing gear 22 has been deployed or in the extended position, the system 100 may generate an alert signal to indicate the deployment of the landing gear 22.

[0048] Fig. 5 shows a flow diagram of an exemplary method 2000 of detecting the deployment of the landing gear 22 of an aircraft 20 during landing.

[0049] In block 2110, the system 100 may survey a specific area of interest 112, which may cover part of the final approach flight path to detect aircraft 20 flying within the selected/pre-configured area of interest 112. Visible light camera 120 and the thermal camera 110 may perform continuous surveillance and monitoring of the area of interest 112.

[0050] In block 2120, the visible light camera 120 and/or the thermal camera 110 may detect an aircraft 20 flying within the area of interest 112.

[0051] In block 2130, the visible light camera 120 and the thermal camera 110 may track the movement and position of the detected aircraft 20 while it is flying along the final approach flight path.

[0052] In block 2140, both the visible light camera 120 and the thermal camera 110 may perform optical zoom-in to capture zoomed-in visible light image and/or thermal image of the landing gear 22.

[0053] In block 2150, the image processing module 134M may process the visible light image and/or the thermal image captured by the visible light camera 120 and the thermal camera 110 to detect the position of the landing gear 22 on the aircraft 20.

[0054] System 100 may determine if the image processing module 134M detects that the position of the landing gear 22 is in extended position in block 2160 in the visible light image and the thermal image.

[0055] If the landing gear 22 is detected to be in the extended position in the visible light image, the system 100 may generate an “Aircraft Landing Gear Extended – Visible Light Camera” alert signal in block 2170. Otherwise, the system 100 may generate an “Aircraft Landing Gear Retracted – Visible Light Camera” alert signal to warn the operator that the position of the landing gear 22 is in retracted position in block 2180.

[0056] If the landing gear 22 is detected to be in the extended position in the thermal image, the system 100 may generate an “Aircraft Landing Gear Extended – Thermal Camera” alert signal in block 2270. Otherwise, the system 100 may generate an “Aircraft Landing Gear Retracted – Thermal Camera” alert signal to warn the operator that the position of the landing gear 22 is in retracted position in block 2280.

[0057] In block 2190, the system 100 may generate an “Aircraft Landing Gear Extended” event only if the landing gear 22 is in the extended position and detected by both the visible light camera 120 and the thermal camera 110. System 100 may not generate an alert signal as the alert signals for the detected extended landing gear 22 in both the visible light image and the thermal image have been generated. Alternatively, in this condition, an “Aircraft Landing Gear Retracted – Visible Light Camera” alert signal and/or an “Aircraft Landing Gear Retracted – Thermal Camera” alert signal may be generated as shown in block 2180 and 2280.

[0058] Thermal camera 110 is able to detect foreign objects 20 by detecting the difference in the temperature, i.e. the infrared thermal radiation of the foreground, e.g. the landing gear 22, with respect to the background, e.g. the surrounding. As the foreground, e.g. landing gear 22 is made of different materials and would have different energy absorptivity, reflectivity and emissivity, from the background, e.g. the surrounding, the foreground would result in different temperature, i.e. different level of infrared thermal radiation, with respect to the background. The difference in temperature between the foreground and the background would be detectable by the thermal camera 110.

[0059] Therefore, it is beneficial to “train” the thermal camera 110, or rather the thermal camera 110 operating module 134T, to differentiate the landing gear 22 or even the aircraft 20, by identifying the type of material which the landing gear 22 is made of. As the foreground, i.e. landing gear 22 is made of materials of different emissivity resulting in different level of temperature and different temperature contrast level with respect to the background, i.e. the surrounding, the “well-trained” thermal camera 110 would be able to identify an aircraft 20 and the landing gear 22 more accurately.

[0060] To train the thermal camera 110. Under normal clear weather conditions, the thermal camera 110 may be put through an initial period of “training” whereby the thermal camera 110 may operate in “training” mode to enable it to “learn” from the visible light images 120M of the visible light camera 120. After the initial “training”, the thermal camera 110 may be adequately “learned” to enable the thermal camera 110 to provide reliable and accurate landing gear 22 detection with relatively high level of accuracy. With a high level of accuracy, it would then be possible to enable a system 100 with a “standalone” thermal camera 110 instead of a set of visible light camera 120 and thermal camera 110. In this way, the system 100 will be applicable under adverse weather conditions and/or very low visibility conditions without the visible light camera 120.

[0061] System 100 may determine the relationship between the foreground, e.g. the aircraft 20, and the temperature of the aircraft 20 in the thermal image 110M. Processor 132 may be further configured to train the thermal camera 110 to detect the aircraft 20 based on the visible light images 120M from the visible light camera 120. As it is substantially easier to identify

the aircraft 20 in visible light image 120M, the system 100 may form a relationship between the aircraft 20 of the visible light image 120M obtained from the visible light camera 120 and the temperature of the thermal image 110M from the thermal camera 110. In this way, the system 100 may be able to identify the aircraft 20 more easily based on the thermal image thereof.

[0062] To optimize the performance of the thermal camera 110, it is necessary to optimize the detection configuration parameters of the thermal camera 110. The detection configuration parameters of the thermal camera 110 may be a set of operating parameters pertaining to the thermal camera 110 to enable the thermal camera 110 to detect the foreground, e.g. the aircraft 20, the landing gear 22, with optimum and high level of accuracy. Operating parameters of the thermal camera 110 may include sensitivity, gain, brightness, contrast, shutter timing settings, etc. In this way, as the system 100 trains the thermal camera operating module 134T, the detection performance of the thermal camera 110 would be improved over time to a level at which it may be able to operate as “standalone” and sole landing gear 22 detector for the system 100, i.e. without the visible light camera 120. The optimized performance thermal camera 110 would be beneficial under adverse weather conditions and/or under very low visibility conditions.

[0063] A skilled person would appreciate that the features described in one example may not be restricted to that example and may be combined with any one of the other examples.

[0064] The present invention relates to a system for detecting the deployment of a landing gear of an aircraft during the landing and a method thereof generally as herein described, with reference to and/or illustrated in the accompanying drawings.

Claim

1. A method for detecting the deployment of a landing gear of an aircraft during landing, the method comprising:
 - monitoring an area of interest along a flight path of the aircraft,
 - detecting the aircraft when it enters the area of interest,
 - identifying a section of the aircraft where the landing gear deploys,
 - capturing at least one of a visible light image and a thermal image of the section,
 - and
 - detecting the deployment of the landing gear in at least one of the visible light image and the thermal image.
2. The method according to claim 1, wherein the area of interest is at a portion of a final approach of the flight path.
3. The method according to claim 1 or 2, wherein monitoring the area of interest comprises capturing a plurality of visible light images and a plurality of thermal images of the area of interest over a period of time.
4. The method according to claim 3, wherein detecting the aircraft comprises identifying the aircraft in one or more of the plurality of visible light images and the plurality of thermal images.
5. The method according to any one of claims 1 to 4, further comprising tracking the movement of the aircraft along the final approach of the flight path.
6. The method according to any one of claims 1 to 5, wherein capturing the at least one of the visible light image and the thermal image of the section comprises capturing at least one of the enlarged visible light image and the enlarged thermal image of the section.
7. The method according to claim 6, wherein detecting the deployment of the landing gear comprises identifying the landing gear in the extended position in the at least one of the visible

light image and the thermal image of the section or the at least one of the enlarged visible light image and the enlarged thermal image of the section.

8. The method according to any one of claims 1 to 7, further comprising generating an alert signal to indicate the deployment of the landing gear when the landing gear is detected to be deployed.

9. A system for detecting the deployment of a landing gear of an aircraft during landing, the system comprising:

- a thermal camera comprising a first field of view and adapted to monitor an area of interest along a flight path of the aircraft and capture a thermal image of the area of interest,

- a visible light camera comprising a second field of view and adapted to monitor the area of interest and capture a visible light image of the area of interest,

- a processor in communication with the thermal camera and the visible light camera,

- a memory in communication with the processor for storing instructions executable by the processor, wherein the processor is configured to,

- monitor the area of interest along the flight path of the aircraft,

- detect the aircraft when it enters the area of interest,

- identify a section of the aircraft where the landing gear deploys,

- capture at least one of a visible light image and a thermal image of the section, and

- detect the deployment of the landing gear in at least one of the visible light image and the thermal image.

10. The system according to claim 9, wherein the area of interest is at a portion of a final approach of the flight path.

11. The system according to claim 9 or 10, wherein to monitor the area of interest, the processor is configured to capture a plurality of visible light images and a plurality of thermal images of the area of interest over a period of time.

12. The system according to claim 11, to detect the aircraft, the processor is configured to identify the aircraft in one or more of the plurality of visible light images and the plurality of thermal images.
13. The system according to any one of claims 9 to 12, wherein the processor is further configured to control the visible light camera and the thermal camera to track the movement of the aircraft along the final approach of the flight path.
14. The system according to any one of claims 9 to 13, wherein the visible light camera and the thermal camera are configured to zoom into the section of the aircraft to capture an enlarged visible light image and an enlarged thermal image of the section, wherein capturing at least one of the visible light image and the thermal image comprises capturing at least one of the enlarged visible light image and the enlarged thermal image of the section.
15. The method according to claim 14, to detect the deployment of the landing gear, the processor is configured to identify the landing gear in the extended position in the at least one of the visible light image and the thermal image of the section or the at least one of the enlarged visible light image and the enlarged thermal image of the section.
16. The method according to any one of claims 1 to 15, wherein the processor is configured to generate an alert signal to indicate the deployment of the landing gear when the landing gear is detected to be deployed.